**Momentum:**

**Linear momentum:**

**p** = m**v** (1)

$p=\sum\_{i=1}^{n}m\_{i}v\_{i}$. (2)

(1) is the expression of linear momentum for one material point.

(2) is the expression of linear momentum for the mechanical system of n material points.

**Collisions**:

We consider **one-dimensional** motion of material points.

**Inelastic** collisions or perfectly inelastic collisions:

Two balls (material points) collide without external forces (without friction, etc.) along the straight line (one-dimensional motion), after the inelastic collision both balls move with the same velocity being stick to each other.

Before the collision the masses and the velocities of the balls are m1 and m2, v1 and v2, respectively.

After the collision the balls move together with the same velocity v.

**Momentum** is **conserved**: momentum before the collision is equal to momentum after the collision.

m1v1 + m2v2 = (m1 + m2)v (3)

$v=\frac{m\_{1}v\_{1}+ m\_{2}v\_{2}}{m\_{1}+ m\_{2}}$ (4)

Example:

m1 = 1kg, m2 = 2kg, v1 = 10m/s, v2 = 2m/s.

Find v for the inelastic collision.

**Elastic** collisions or perfectly elastic collisions:

This is more complex problem because instead of one unknown v there two unknowns V1 and V2.

This time we use the law of conservation of kinetic energy in addition to the law of conservation of momentum.

There two simultaneous equations to solve in this case for V1 and V2.

m1v1 + m2v2 = m1V1 + m2V2 (5)

$\frac{m\_{1}v\_{1}^{2}}{2}+\frac{m\_{2}v\_{2}^{2}}{2}=\frac{m\_{1}V\_{1}^{2}}{2}+\frac{m\_{2}V\_{2}^{2}}{2}$ (6)

These simultaneous equations are quadratic; there will be two solutions for V1 and two solutions for V2.

We must choose the correct solutions based on the physical conditions.

We solve the quadratic simultaneous equations by substitution, expressing V2 through V1 from the first equation and substituting the expression into the second equation.

$V\_{2}=\frac{m\_{1}v\_{1}+m\_{2}v\_{2}-m\_{1}V\_{1}}{m\_{2}}$ (7)

Substituting (7) to (6), we get the single quadratic equation for V1. By solving the single quadratic equation and finding two values of V1, we must decide with of the two answers is the correct physical value for V1.

V2 can be found through V1 using (7).

Example:

m1 = 1kg, m2 = 2kg, v1 = 10m/s, v2 = 2m/s.

Find V1 and V2 for the elastic collision.